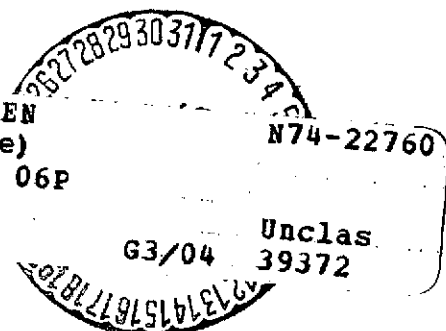


BED REST AND NITROGEN BALANCE

H. Noelle

Translation of "Bettruhe und Stickstoffbilanz", Therapie der Gegenwart, Vol. 103, April 1964, pp. 509 - 526.

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16. Abstract Bed rest alone does not cause negative nitrogen balance. Patients requiring bed rest often have increased protein requirements because of effects of disease.					
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BED REST AND NITROGEN BALANCE

H. Noelle

In few areas of scientific research have the experimental systems changed so little as in protein balance studies. The protocol presented by Bischoff and Voit in a monograph [1] in 1860 is still today the guide in completeness of detail and in the precision of the study conditions, although the methodology has changed to follow advances. The nitrogen-sparing effect of carbohydrates and fat was observed more than 100 years ago.

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About the turn of the century, Rubner published results from metabolism research. His investigations are still uncontested. This is the more surprising, as the laws of energy consumption were established with only three test subjects, along with numerous animal experiments. Thus, it lacks the statistical guarantees which are common today, and which are provided by the Anglo-Americans in particular. But this can be no surprise for

W. Hirsch has treated "Bed Rest as Medication" from the general viewpoints in this journal. Bed rest is still the most frequent "medical" treatment. As deeper views into metabolic processes have become possible, it appeared important to us to attack this problem once more - from a special viewpoint, admittedly. Also, some questions of catabolic and anabolic regulation in metabolism and the effect of medications on them were presented here recently (F. Hohensee: Ther. d. Gegenw., 102:1173(1963).

The Editors

* Numbers in the margin indicate pagination in the original foreign text.

anyone undertaking his own balance investigations. The accuracy of Rubner's results is not doubted because the major sources of error are not in the analytical methodology but in the low reliability of the people studied, with respect to the intake of food as well as to the precise collection of the stool and urine quantity. Here, Rubner apparently gained a measure of cooperation which make possible a maximally reliable statement with a small number of experimental results. Perhaps more attention should be paid to that, and the accuracy of the results measured less by the size of the group investigated and more by the precision of the investigation.

Intermediary metabolism is in the foreground of research today. It may appear presumptuous to seek new findings with a primitive experimental system such as that for nitrogen balance. The justification for it, though, is in the importance of protein for nutrition. Judging the value of certain protein carriers by building block analysis, or analyzing the total diet for its content of amino acids is a requirement which can hardly be realized in clinical medicine. Also, it appears unnecessary, as the calculations from building block analysis are not always applicable [5] and the value of the protein for nutrition can be determined from the balance. Accordingly, a positive balance cannot be attained in the absence of the amino acids which are essential for building the body substance.

If there is no doubt of the importance of protein intake for healthy people, this is even more true for the sick. The organism needs protein both for humoral defense and for synthesis of substances destroyed through sickness. It is useful to know what protein losses must be expected in patients and whether faster recovery can be attained through the level in the diet.

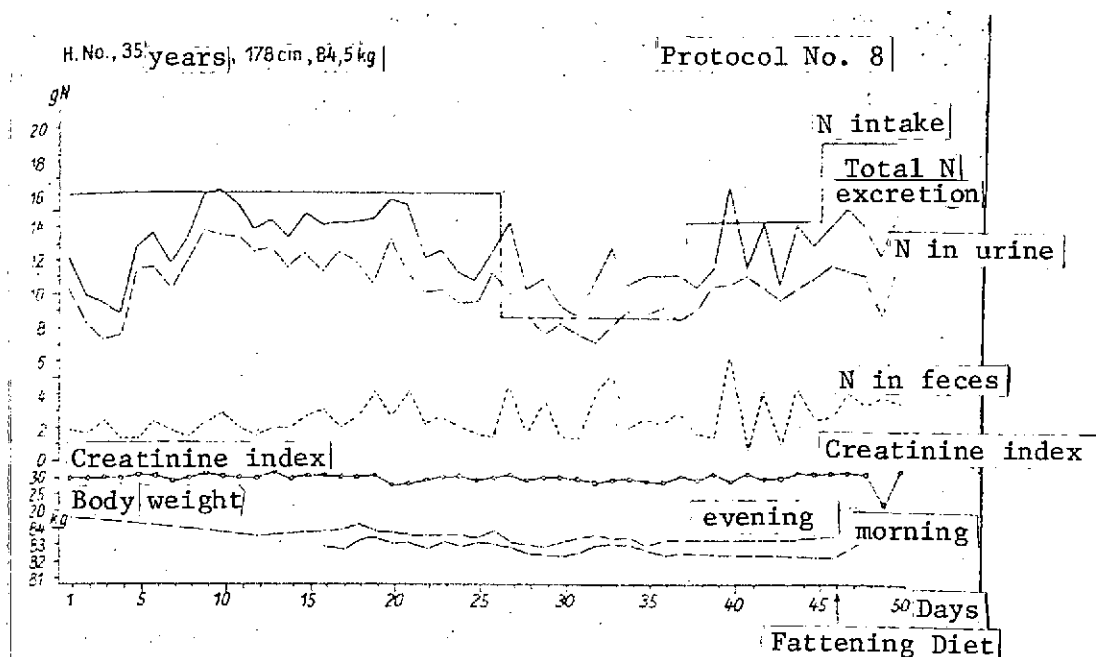
The following experimental system was used in the 1900 individual analyses:

1. Determine caloric value and nitrogen content of daily diet
2. Do not alter the composition and origin of daily food
3. Determine body weight morning and evening at the same time, after emptying bladder
4. Collect 24-hour samples of feces and urine; determine creatinine index in urine
5. Daily analysis of fecal and urinary nitrogen excretion.

The sources of error are:

1. Additional food intake
2. Inaccurate collection of feces and urine
3. Incomplete intake of food.

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Curve 1. Preliminary period, 1-15 days; bed rest, up to 37th day.

In order to prevent the protein given from being used for production of calories, the caloric provision from carbohydrates and fats must be such that the body weight rises during the analysis.

Determination of the nitrogen content in feces, urine and food is done by the method of Conway [8].

Before testing whether diseases affect the height of the nitrogen excretion, it appeared necessary to us to clarify whether bedrest alone affected the nitrogen excretion. With healthy test subjects it has been observed that, after a preliminary period with positive balance and an intake of 54 g protein daily, there was increased excretion and a negative balance during bed rest [4]. It is believed that the increased nitrogen excretion is due to reduced synthesis [11].

It appears generally recognized today that immobilization causes catabolic processes. Is this assumption always correct? In order to test this question, we performed a self-experiment.

TABLE 1. BED REST FROM 16-th TO 37-th DAY. NO WEIGHT GAIN*

H. No. 35, 178 cm, 84.5 kg

Protocol No. 8

Experimental day No.	Date	Diet	Body weight			Urine Volume ml	Creatinine Nitrogen g/g	index	Feces Daily Amount g	Nitrogen g	Daily nitrogen excretion	Nitrogen balance
			Morning kg	Evening kg	Overnight loss kg							
1	19.1.59	2550 Kcal		84.5		1000	10.2	29.1	273	1.8	12.0	+3.8
2	20.1.59	62 g Fat				905	8.2	28.1	208	1.6	9.8	+6.0
3	21.1.59	98.8 g Protein				900	7.1	29.4	300	2.2	9.3	+6.5
4	22.1.59	384 g Carbohydrate				985	7.4	28.4	175	1.2	8.6	+7.2
5	23.1.59	15.8 g N				1240	11.3	30.4	145	1.2	12.5	+3.3
6	24.1.59					980	11.3	28.7	274	2.1	13.4	+2.4
7	25.1.59					850	10.0	25.5	214	1.6	11.6	+4.2
8	26.1.59					910	11.7	27.7	81	1.3	13.0	+2.8
9	27.1.59					990	13.6	31.2	150	2.1	15.7	+0.1
10	28.1.59					840	13.3	29.3	193	2.6	15.9	-0.1
11	29.1.59					835	13.2	28.0	115	1.8	15.0	+0.8
12	30.1.59			83.4		940	12.3	27.7	117	1.3	13.6	+2.2
13	31.1.59					930	12.5	30.6	109	1.7	14.2	+1.6
14	1.2.59					885	11.4	27.9	369	1.7	13.1	+2.7
15	2.2.59					990	12.1	29.0	123	2.4	14.5	+1.3
16	3.2.59		82.7	83.6		950	11.1	28.8	261	2.8	13.9	+1.9
17	4.2.59		82.6	83.7	1.0	920	12.2	28.0	142	1.8	14.0	+1.8
18	5.2.59		83.0	84.0	0.7	900	11.6	28.0	182	2.4	14.0	+1.8
19	6.2.59		83.2	83.6	0.8	950	10.4	29.0	272	3.8	14.2	+1.6
20	7.2.59		82.9	83.5	0.7	1020	13.0	24.2	183	2.4	15.4	+0.4
21	8.2.59	2550 Kcal	82.9	83.3	0.6	920	11.1	24.2	322	3.9	15.0	+0.8
22	9.2.59	62 g Fat	82.6	83.3	0.7	820	9.9	26.1	150	2.0	11.9	+3.9
23	10.2.59	98.8 g Protein	82.9	83.3	0.4	935	9.9	27.7	212	2.4	12.3	+3.5
24	11.2.59	384 g Carbohyd.	82.6	83.3	0.7	800	9.2	28.4	159	1.8	11.0	+4.8
25	12.2.59	15.8 g N	82.8	83.1	0.5	860	9.2	26.3	100	1.3	10.5	+5.3
26	13.2.59		82.8	83.5	0.3	1000	10.9	27.5	85	1.2	12.1	+3.7
27	14.2.59	2630 Kcal	82.6	82.9	0.9	770	9.7	29.3	310	4.2	13.9	-5.7
28	15.2.59	87 g Fat	82.2	82.7	0.7	660	8.6	26.4	153	1.4	10.0	-1.8
29	16.2.59	51.3 g Protein	82.2	82.6	0.5	575	7.3	27.0	185	3.3	10.6	-2.4
30	17.2.59	391 g Carbohyd.	82.1	82.9	0.5	655	7.9	27.9	65	1.1	9.0	-0.8
31	18.2.59	8.2 g N	82.2	83.1	0.7	610	7.3	27.3	63	1.1	8.4	-0.2
32	19.2.59		82.6	83.3	0.5	540	6.8	25.0	253	3.7	10.5	-2.3
33	20.2.59		82.8	83.1	0.5	730	7.7	25.8	317	4.8	12.5	-4.3
34	21.2.59		82.7	83.2	0.4	700	8.6	25.7	108	1.7	10.3	-2.1
35	22.2.59		82.5	82.7	0.7	560	8.5	25.2	130	2.2	10.7	-2.5
36	23.2.59		82.2	83.0	0.5	680	8.8	24.7	136	1.9	10.7	-2.5
37	24.2.59		82.2		0.8	620	8.1	27.7	152	2.6	10.7	-2.5
38	25.2.59	2580 Kcal				580	8.7	25.4	74	1.3	10.0	+4.0
39	26.2.59	80 g Fat				700	10.1	29.0	49	1.1	11.2	+2.8
40	27.2.59	87.5 g Protein				790	10.2	25.0	337	5.8	16.0	-1.0
41	28.2.59	360 g Carbohyd.				730	10.7	28.8	24	0.4	11.1	+2.9
42	29.2.59	14.0 g N				820	10.1	25.7	350	3.8	13.9	+0.1
43	30.2.59					685	9.3	27.0	45	0.8	10.1	+3.9
44	31.2.59			83.0		1000	9.9	29.0	310	4.0	13.9	+0.1
45	4.3.59		81.9		1.1	850	10.5	28.6	144	2.1	12.6	+1.4
46	5.3.59	5125 Kcal	81.9	83.1		985	11.3	28.7	168	2.3	13.0	+5.7
47	6.3.59	246.0 g Fat	82.4		0.7	820	11.0	29.1	297	3.7	14.7	+4.0
48	7.3.59	116.9 g Protein	82.9			1020	10.7	29.4	263	3.0	13.7	+5.0
49	8.3.59	575.0 g Carbohyd.	83.0			2015	8.4	20.0	269	3.5	11.9	+6.3
50	9.3.59	18.7 g N	83.1			1000	11.6	29.5	283	3.1	14.7	+4.1

* Translator's note: Commas in numbers represent decimal points.

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In the balances, the nitrogen loss through the skin was not /516 taken into consideration. This amounts to 250 mg N/m²/day in men and 120 mg N/m²/day in women [6]. According to other authors, the loss in the sweat is said to be 13% of the intake [2].

During a preliminary period of 15 days the diet contained 2,550 Calories, 33 Calories/kg desired weight, 30 Calories/kg actual weight; 98.8 g protein, 1.23 g protein/kg desired weight, 1.13 g protein/kg actual weight; 15.8 g nitrogen, 187 mg N/kg actual weight, 202 mg nitrogen/kg desired weight; 62 g fat; and 384 g carbohydrates. This gave:

Total intake: 237.0 g N (15.8 g nitrogen/day)

Total excretion: 192.2 g N (12.8 g nitrogen/day)

of this, the

urine contained 165.6 g N (11.0 g/day)

feces contained 26.6 g N (1.8 g/day)

Nitrogen balance in 15 days = +44.8 g N; absorption coefficient: 18.9%

$$\text{Absorption Coefficient} = \frac{\text{Intake} - (\text{Excretion [urine]} + \text{Excretion [Feces]})}{\text{Intake}} \times 100$$

This period was followed by 3 weeks of bed rest. During this, any movement in bed was avoided, and bed was left only for a few minutes in the morning and evening. The diet remained unchanged in the first 11 days.

Intake: 173.8 g N

Total excretion: 144.3 g N = 13.1 g/day

in urine: 118.0 g N = 10.8 g/day

in feces: 2.8 g N = 2.3 g/day

Nitrogen balance in 11 days: +29.5%; absorption coefficient: +11.2%.

If we take the last 11 days before beginning of bed rest for comparison, we find:

Total excretion:	152.5 g N	=	13.9 g N/day
in urine:	132.7 g N	=	12.1 g N/day
in feces:	19.8 g N	=	1.8 g N/day
Nitrogen balance:	+ 21.3 g N		
Absorption coefficient:	+ 12.3%		

According to this, no increase in nitrogen excretion occurred during this period.

The body weight remained constant.

In the following 11 days the number of calories was increased /518 and the proportion of protein decreased:

2,630 Calories, 34 Cal/kg desired weight, 32 Cal/kg actual weight; 51.3 g protein = 0.66 g protein/kg desired weight, 0.62 g protein/kg actual weight; 8.2 g N/day = 105 mg N/kg desired weight, 99 mg N/kg actual weight; 87 g fat, 391 g carbohydrate.

Total intake in 10 days:	82.0 g N		
Total excretion:	106.6 g N	=	10.6 g N/day
in urine:	81.2 g N	=	8.1 g N/day
in feces:	25.4 g N	=	2.5 g N/day
Nitrogen balance:	- 24.6 g N		
Absorption coefficient:	- 30%		

The body weight decreased by 400 g. With high caloric intake the nitrogen provided was too low to attain a compensated balance.

The body weight decreased by 664 g/night in the first 11 days of bed rest with positive nitrogen balance, and by 580 g/night in the following 11 days at negative balance. Absence of weight gain can be ascribed to an increase in conversion with absence of activity.

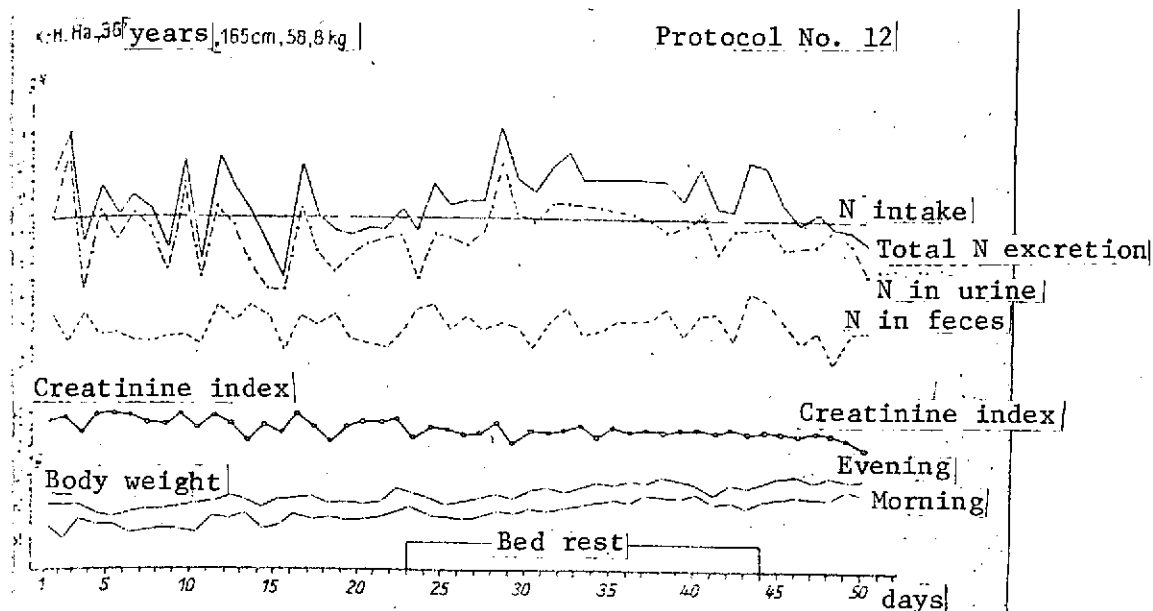
With an increase of the protein intake to 87.5 g = 1.12 grams protein/kg desired weight, 1.06 g protein/kg actual weight; 14.0 g N = 179 mg N/kg desired weight, 170 mg N/kg actual weight, 80 g fat and 360 g carbohydrates, 2,580 Calories/day, the balance after arising was positive.

Discussion

In a healthy person, bed rest has no effect on the level of nitrogen excretion if the daily intake is 30 Calories/kg actual weight and 1.13 g protein/kg actual weight. The balance becomes negative at an intake of 32 Calories/kg actual weight and 0.6 g protein/kg actual weight. It is important that the necessary preliminary period which must especially be observed on reduction of the intake could not be maintained here. It is a question of the time when the organism has adapted to the low intake. But for the clinical problem, we must draw the conclusion that on immobilization the level of protein intake should not be under 1.0 g/kg/day if adequate carbohydrate and fat are provided.

Investigations with Patients

The questions related to immobilization appeared so important that investigations were also undertaken with patients not suffering from metabolic diseases.



Curve 2. Bed rest with anacidity and liver parenchymal damage.
Increase in nitrogen excretion.

The 36-year-old patient, K. H. Ha. was treated for mild liver function disturbance after dystrophy and stomach anacidity. Diet: 2,630 Cal; 40 Cal/kg desired weight, 44 Cal/kg actual weight; 54 g protein = 0.83 g protein/kg desired weight, 0.92 g protein/kg actual weight; 8.6 g N = 132 mg N/kg desired weight, 1.46 mg N/kg actual weight; 87 g fat, 391 g carbohydrate (Curve 2; Table 2).

Preliminary period, 3 weeks.

In this time:

Total N excretion:	187.2 g N = 8.91 g N/day
Urine N excretion:	150.1 g N = 7.13 g N/day
Fecal N excretion:	37.1 g N = 1.77 g N/day
Nitrogen balance:	- 6.6 g N

3 weeks bed rest:

Total N excretion:	222.5 g N	=	10.6 g N/day
Urine N excretion:	173.8 g N	=	8.28 g N/day
Fecal N excretion:	48.7 g N	=	2.32 g N/day
Nitrogen balance:	- 41.9 g N		
Weight increase:	0.4 kg		

Here we can see a distinct increase of nitrogen excretion during bed rest. In comparison of the two 21-day periods, it is manifested primarily in the urine nitrogen excretion, but also to a lesser extent in the magnitude of the fecal nitrogen excretion.

The effect of one week of bed rest was investigated with two patients:

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(The two following balance experiments have already been reported in detail elsewhere [9]; thus, only the results are shown.)

A 44-year-old woman was treated in the hospital for *Ulcus ad pylorum*. Balance investigation over 31 days.

Preliminary period: 10 days with 2,000 Calories; 36 Cal/kg desired weight, 40 Cal/kg actual weight; 55.4 g protein, 1.0 g protein/kg desired weight, 1.12 g protein/kg actual weight; 8.86 g N = 158 mg N/kg desired weight, 179 mg N/kg actual weight; 60 g fat, 298 g carbohydrate.

Further 11 days: 2,200 Calories; 39 Cal/kg desired weight, 45 Cal/kg actual weight; 56 g protein, 1.0 g protein/kg desired weight, 1.15 g protein/kg actual weight; 8.96 g N = 184 mg N/kg actual weight, 160 mg N/kg desired weight; 66 g fat, 330 g carbohydrate.

In the week preceding bed rest:

Total N excretion:	68.97 g	=	9.85 g N/day
Urine N excretion:	55.85 g	=	7.99 g N/day
Fecal N excretion:	13.12 g	=	1.87 g N/day
Nitrogen balance:	-6.25		

7 days bed rest:

Total N excretion:	78.08 g	=	10.87 g N/day
Urine N excretion:	66.95 g	=	9.56 g N/day
Fecal N excretion:	9.13 g	=	1.3 g N/day
Nitrogen balance:	-13.36 g N		

In this patient, also, the nitrogen excretion increased in bed rest.

The 48-year-old patient was treated because of functional epigastric complaints with hyperacidity of the gastric juice.

Balance investigation over 32 days, of which 9 days were strict bed rest.

9 days before beginning of immobilization:

Total N excretion:	87.21 g N	=	9.69 g N/day
Urine N excretion:	71.33 g N	=	7.92 g N/day
Fecal N excretion:	15.88 g N	=	1.76 g N/day
Nitrogen balance:	+ 3.69 g N		

9 days bed rest:

Total N excretion:	102.65 g N	=	11.44 g N/day
Urine N excretion:	82.21 g N	=	9.13 g N/day
Fecal N excretion:	20.44 g N	=	2.27 g N/day
Nitrogen balance:	-11.75 g N		
Weight increase:	0.8 kg		

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TABLE 2. BED REST WITH ANACIDITY AND LIVER PARENCHYMAL DAMAGE (23-rd - 44-th DAY)*

Experimental day No.	date	diet	Body weight			Urine			Feces			Nitrogen balance
			Morning	Evening	Overnight	Daily	Creatinine Index	Daily Amount	Nitrogen g	Total N excretion g		
			kg	kg	loss kg	Volume ml					Nitrogen g	
1	2.7.59	2630 kcal	58.8	60.0		700	8.8	30.6	249	2.7	11.5	-2.9
2	3.7.59	87 g Fat	58.1	60.0	1.9	900	12.4	34.6	92	1.2	13.6	-5.0
3	4.7.59	54 g Protein	59.3	60.0	0.7	400	4.3	16.0	237	2.8	7.1	+1.5
4	5.7.59	391 g Carbohydrate	59.0	59.5	1.0	700	8.8	35.8	116	1.6	10.4	-1.8
5	6.7.59	8.6 g N	58.9	59.3	0.6	500	7.3	37.9	269	1.5	8.8	-0.2
6	7.7.59		58.4	59.6	0.9	600	8.7	37.4	87	1.2	9.9	-1.3
7	8.7.59		58.5	59.8	1.1	500	7.9	26.7	76	1.1	9.0	-0.4
8	9.7.59		58.7	59.8	1.1	400	6.4	26.0	80	1.3	6.7	+1.9
9	10.7.59		58.7	60.0	1.1	600	10.6	36.8	101	1.4	12.0	-3.4
10	11.7.59		58.5	60.2	1.5	300	5.0	23.2	75	1.1	6.1	+2.5
11	12.7.59		59.3	60.3	0.9	630	9.2	36.4	255	3.1	12.3	-3.7
12	13.7.59		59.2	60.6	1.1	670	7.9	27.2	130	2.4	10.3	-1.7
13	14.7.59		59.5	60.4	1.1	1000	5.7	17.4	197	3.2	8.9	-0.3
14	15.7.59		58.7	60.0	1.7	680	4.2	25.9	211	2.6	6.8	+1.8
15	16.7.59		58.9	60.4	1.1	430	4.2	18.7	68	0.6	4.8	+3.8
16	17.7.59		59.5	60.5	0.9	790	9.1	40.5	246	2.6	11.7	-3.1
17	18.7.59		59.3	60.6	1.2	520	6.4	25.0	250	2.2	8.6	±0
18	19.7.59		59.3	60.2	1.3	1050	5.2	9.6	230	2.6	7.8	+0.8
19	20.7.59		59.2	60.2	1.0	400	6.2	25.5	142	1.3	7.5	+1.1
20	21.7.59		59.3	60.1	0.9	450	6.9	32.6	226	1.0	7.9	+0.7
21	22.7.59		59.1	60.3	0.7	450	7.2	33.0	71	0.7	7.9	+0.7
22	23.7.59		59.2	61.0	0.6	650	7.5	36.4	123	1.6	9.1	-0.5
23	24.7.59	2630 kcal	60.0	60.8	1.0	500	4.9	16.0	217	2.9	7.8	+0.8
24	25.7.59	87 g Fat	59.6	60.5	1.2	900	7.5	26.2	240	3.2	10.7	-2.1
25	26.7.59	54 g Protein	59.5	60.1	1.0	830	7.4	26.0	138	1.9	9.3	-0.7
26	27.7.59	391 g Carbohydrate	59.4	60.3	0.7	600	7.0	19.7	165	2.6	9.6	-1.0
27	28.7.59	8.6 g N	59.5	60.6	0.8	950	7.8	21.6	147	1.8	9.6	-1.0
28	29.7.59		59.8	60.7	0.8	750	11.8	33.8	242	2.2	14.0	-5.4
29	30.7.59		59.7	60.6	1.0	750	9.0	10.7	137	2.0	11.0	-2.4
30	31.7.59		59.9	61.0	0.7	700	8.4	25.0	62	0.8	9.2	-0.6
31	1.8.59		59.8	61.1	1.2	900	9.3	23.6	180	2.3	11.0	-3.0
32	2.8.59		60.1	61.0	1.0	900	9.4	26.5	270	3.1	12.5	-3.9
33	3.8.59		60.1	61.2	0.9	840	9.3	32.5	140	1.6	10.9	-2.3
34	4.8.59		60.4	61.5	0.8	730	9.2	19.3	137	1.8	11.0	-2.4
35	5.8.59		60.5	61.4	1.0	890	8.6	30.4	180	2.3	10.9	-2.3
36	6.8.59		60.4	61.6	1.0	940	8.7	25.8	193	2.5	11.0	-2.4
37	7.8.59		60.7	61.5	0.9	860	8.5	26.0	188	2.4	10.9	-2.5
38	8.8.59		60.7	61.7	0.8	690	7.8	25.0	257	3.1	10.9	-2.3
39	9.8.59		60.6	61.5	1.1	720	8.2	28.3	100	1.5	9.7	-1.1
40	10.8.59		60.8	61.3	0.7	830	8.8	28.4	188	2.8	11.6	-3.0
41	11.8.59		60.3	60.8	1.0	1030	6.5	27.2	160	2.8	9.3	-0.7
42	12.8.59		60.3	61.3	0.5	700	7.8	28.6	81	1.2	9.0	-0.4
43	13.8.59		60.1	61.2	1.2	630	7.9	26.4	336	4.1	12.0	-3.4
44	14.8.59		60.4	61.5	0.8	800	8.0	28.3	263	3.6	11.6	-3.0
45	15.8.59		60.5	61.8	1.0	890	6.9	26.0	180	2.5	9.4	-0.8
46	16.8.59		60.7	61.9	1.1	1100	7.0	23.0	167	1.2	8.2	-0.4
47	17.8.59		60.5	61.5	1.4	740	7.1	27.4	148	1.8	8.9	-0.3
48	18.8.59		60.5	61.9	1.0	650	8.1	25.0	—	—	8.1	-0.5
49	19.8.59		61.1	61.6	0.8	600	6.1	20.5	164	1.8	7.9	+0.7
50	20.8.59		60.8	61.8	0.8	480	5.3	11.6	132	1.8	7.1	+1.5

* Translator's note: Commas in numbers represent decimal points.

The increased nitrogen excretion leading to a negative balance was even more distinct than for the previous patient. The nitrogen excretion in the feces during bed rest was also greater in comparison with the preliminary period.

Evaluation

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The changes in intermediary metabolism after injuries, which can cause a negative balance, have become the object of intensive research. No unambiguous explanation for this phenomenon has yet been possible. Five different mechanisms which could cause an increased concentration of amino acids in the cytoplasm of the liver cells have been placed in consideration [3]. The negative balance is then the result of increased formation and elimination of urea. Increased glucocorticoid production is of less importance for post-traumatic nitrogen loss than was believed earlier. The role of the catecholamines has moved into the foreground. It is not generally recognized that the thyroid gland participates decisively in these processes. The observations and the division of the pre- and post-operative periods into 5 phases are important for surgeons [12]. The decrease of anabolic processes alone is hardly decisive for the extent of nitrogen loss. But catabolism in the musculature can overcome increased anabolism in the liver and other organs and cause a negative balance.

In our own experiments, we did not establish a negative nitrogen balance in a healthy person even with strict bed rest, in which every unnecessary movement in bed was avoided, with a caloric intake of 33 Calories/kg desired weight and 1.23 g protein/kg desired weight. In the other 3 balance studies, even a provision of 1.0 g protein/kg body weight and 36 Cal/kg body weight was not sufficient to keep the balance positive. This, then, allows the question of whether the disease does not affect the balance here. For the patients who suffered from

laparoscopically detectable liver parenchymal damage, we must consider these changes to be the cause of the negative balance. One of the patients had an Ulcus ad pylorum and the other had hyperacidity with functional epigastric complaints. With the methodology used we cannot determine with adequate certainty whether the nitrogen loss during bed rest with these stomach diseases is related to the findings in the exudative enteropathy [7], but it seems possible. For practice, it appears that patients who must maintain strict bed rest can have a greater protein requirement than in times with physical activity, even if the caloric intake from carbohydrates and fats is able to prevent weight loss. 1.0 g protein/kg body weight, 2/3 of which is of animal origin, is not always enough to prevent loss. But increased nitrogen intake can produce a positive balance, as we were able to show in other experiments. The degradation of muscle protein in immobilization can, accordingly, be overcome by anabolic processes in other organs or organ systems, so that it is not allowable to call the predominance of catabolic processes a result of immobilization without any other considerations. / 526

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